Homogenized ground-based and profile ozone datasets from the TOAR-II/HEGIFTOM project: methods and station trends

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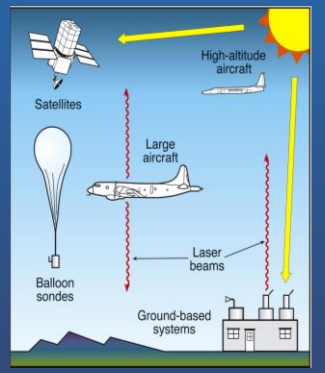


http://hegiftom.meteo.be/

Introduction to TOAR-II Focus Working Group: HEGIFTOM

Harmonization and Evaluation of Ground-based Instruments for Free Tropospheric Ozone Measurements

Key Objective:
Evaluation and harmonization of the different free tropospheric ozone profiling datasets of the established measuring platforms (in-service aircraft, ozonesondes, Brewer/Dobson Umkehr, FTIR, Lidar).

Major Deliverable:
Quality assessed ozone data sets, whereby each measurement gets also an ***uncertainty*** and a ***quality flag***. Thereby, ***representativeness*** and ***instrumental drifts*** will be characterized and evaluated.

Including:
Testing ozone retrievals from new remote sensing techniques (MAX-DOAS, Pandora) against the established techniques.

IAGOS

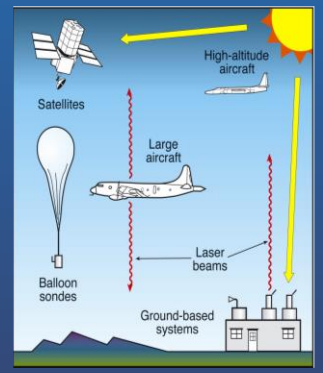

Ozonesondes


Brewer/Dobson Umkehr


FTIR


Lidar

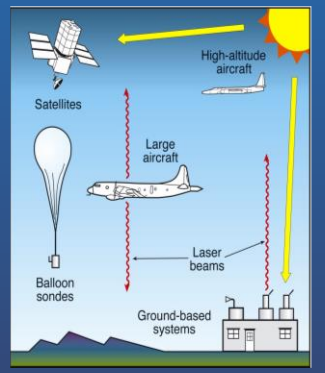

MAX-DOAS & Pandora



http://hegiftom.meteo.be/datasets

Outline

- Homogenization and internal consistency
- External consistency: intercomparisons
- Tropospheric ozone column trend estimates
- Outlook

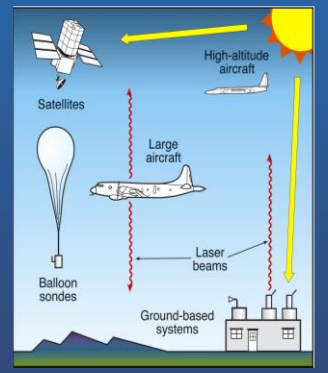


Homogenized datasets and internal consistency

Achievements and updates:

- **IAGOS**:
  - internal consistency paper published in AMT (Blot et al., https://doi.org/10.5194/amt-14-3935-2021),
  - simulation chamber comparison of IAGOS-CORE UV-photometer and reference photometer for ozonesondes
- **Lidar**: TMF data has been updated with new data processor, OHP will follow
- **FTIR:** flagging applied to the NDACC data
- **Brewer/Dobson Umkehr**:
  - 5 Dobson Umkehr sites have been homogenized (Petropavlovskikh et al., https://doi.org/10.5194/amt-15-1849-2022), 1 to go.
  - Updated uncertainty estimation of the retrievals.
- **ozonesondes**:
  - 12 more sites homogenized, e.g. OHP: Ancellet et al., https://doi.org/10.5194/amt-15-3105-2022 (10-15/55 remaining)
  - WMO-GAW report on Ozonesonde Measurement Principles and Best Operational Practices (https://library.wmo.int/doc_num.php?explnum_id=10884)

TOAR tropospheric ozone assessment report Phase II



INTERNATIONAL GLOBAL ATMOSPHERIC CHEMISTRY IGAC

Homogenized datasets

Deliverable: Homogenized free tropospheric ozone profile data, described at HEGIFTOM website, with same template for each dataset:

Availability

location (ftp, data archive, website, doi, e-mail address contact person, etc.).

Data field description

Measured data fields (and their units), incl. auxiliary data fields, available metadata. Data format

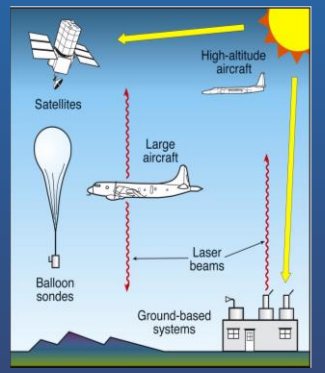
Description of homogenization procedure

short description of the steps taken to make the dataset (more) homogeneous within the network.

Data management

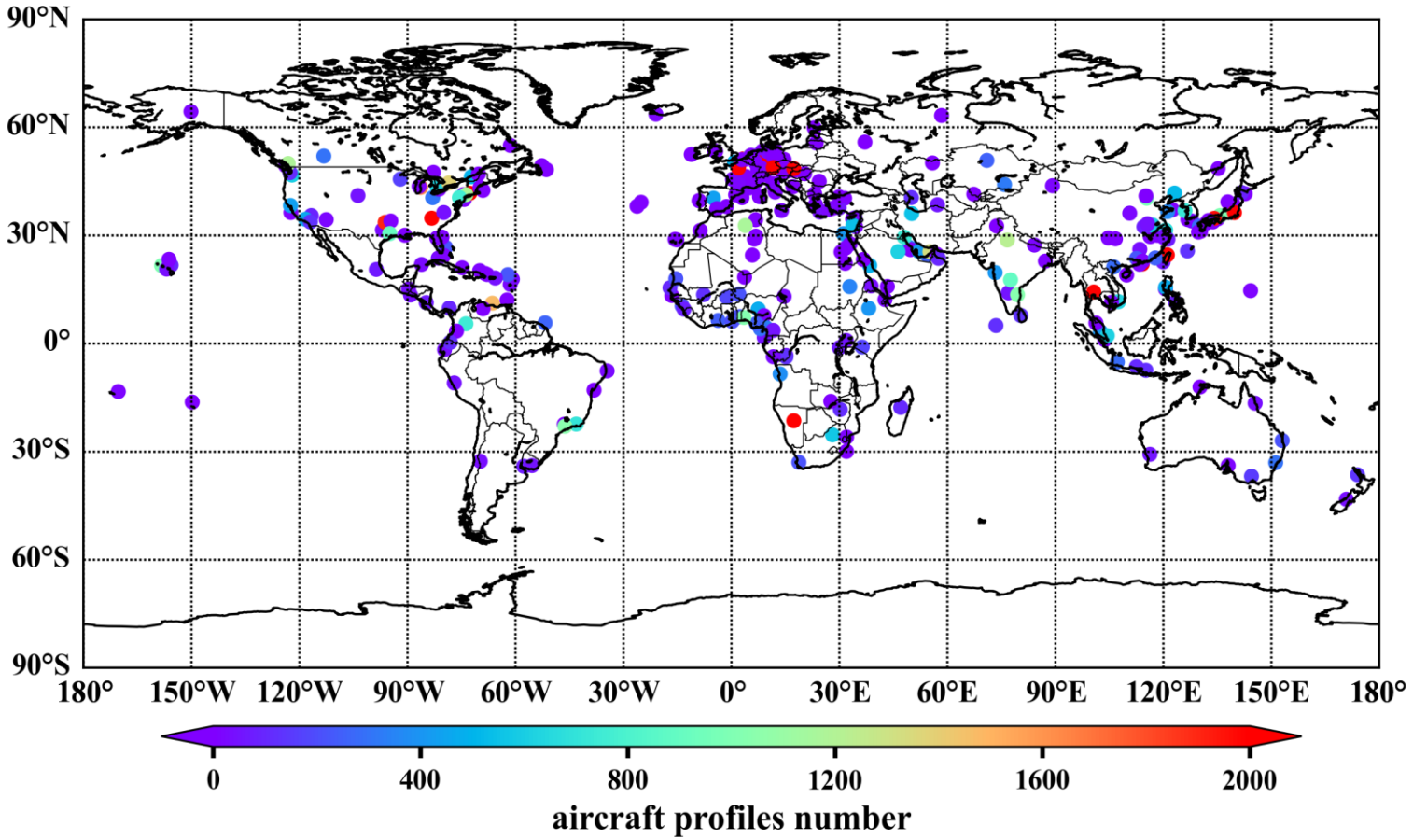
- *Flagging*
- *Uncertainties*
- *Traceability*
- *Internal consistency*
- *External consistency*
- *Data quality indicators*
- *List of homogenized sites (name, geographical location, period of observations)*

https://hegiftom.meteo.be/datasets



Homogenized datasets: IAGOS

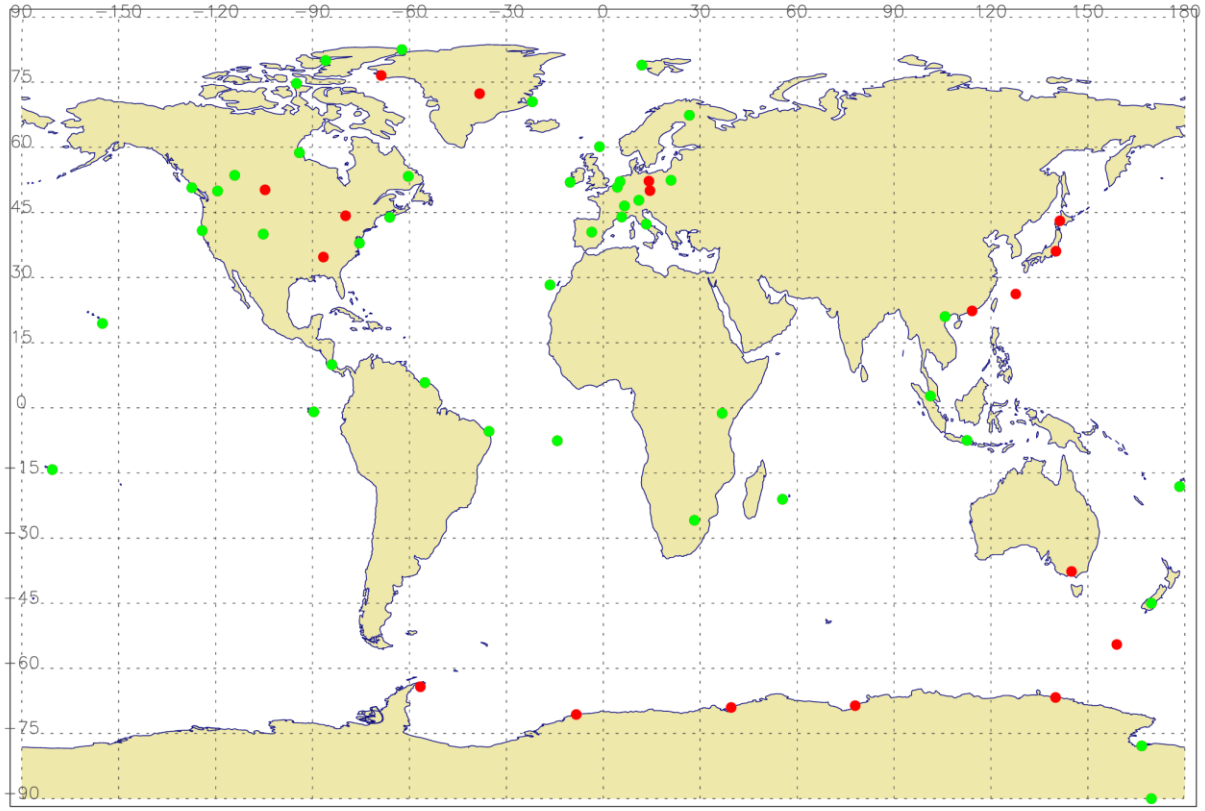
Map of airports

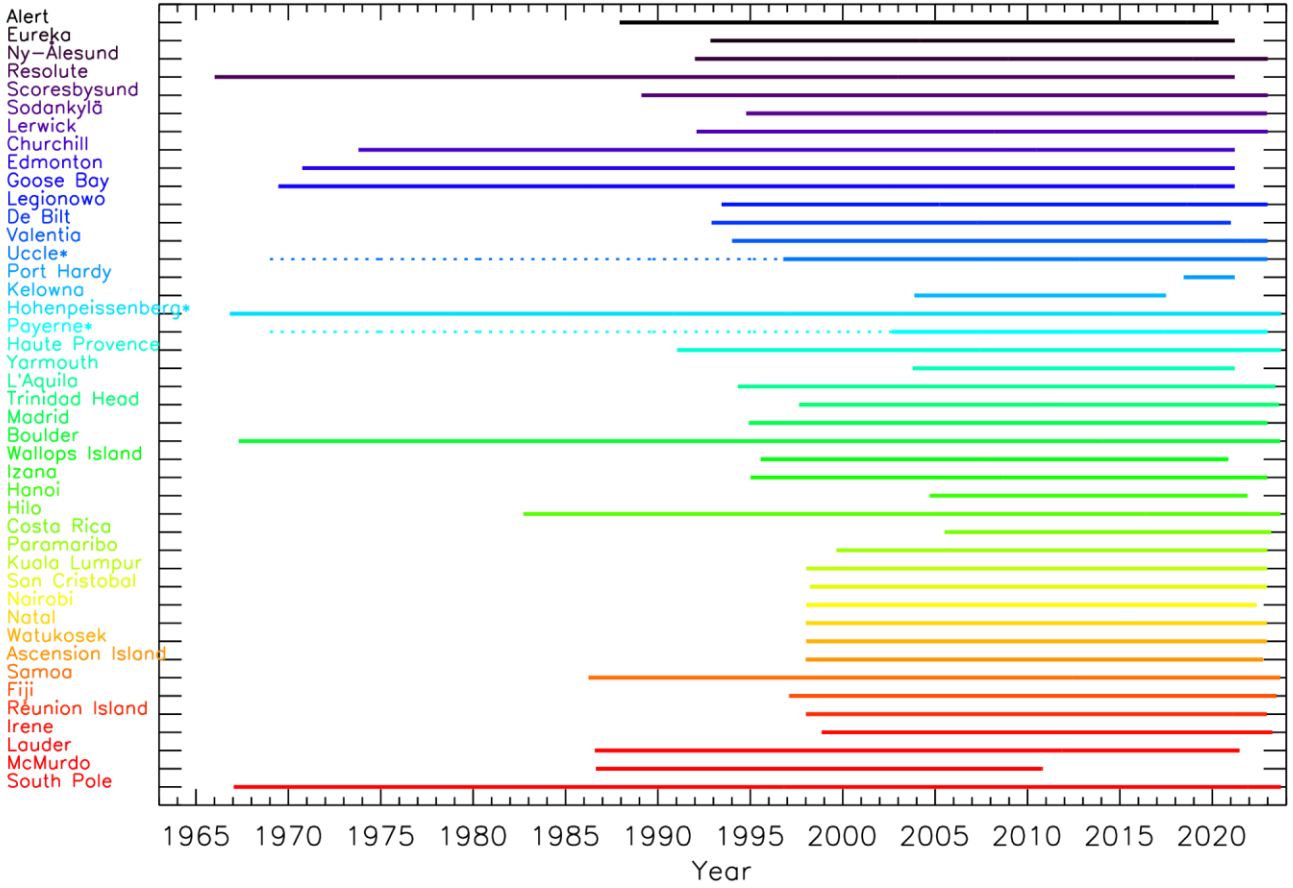


https://hegiftom.meteo.be/datasets/iagos
http://iagos-data.fr/#TimeseriesPlace

1994/08 to 2021/03
310 stations
122574 profiles

Homogenized datasets: Ozonesondes

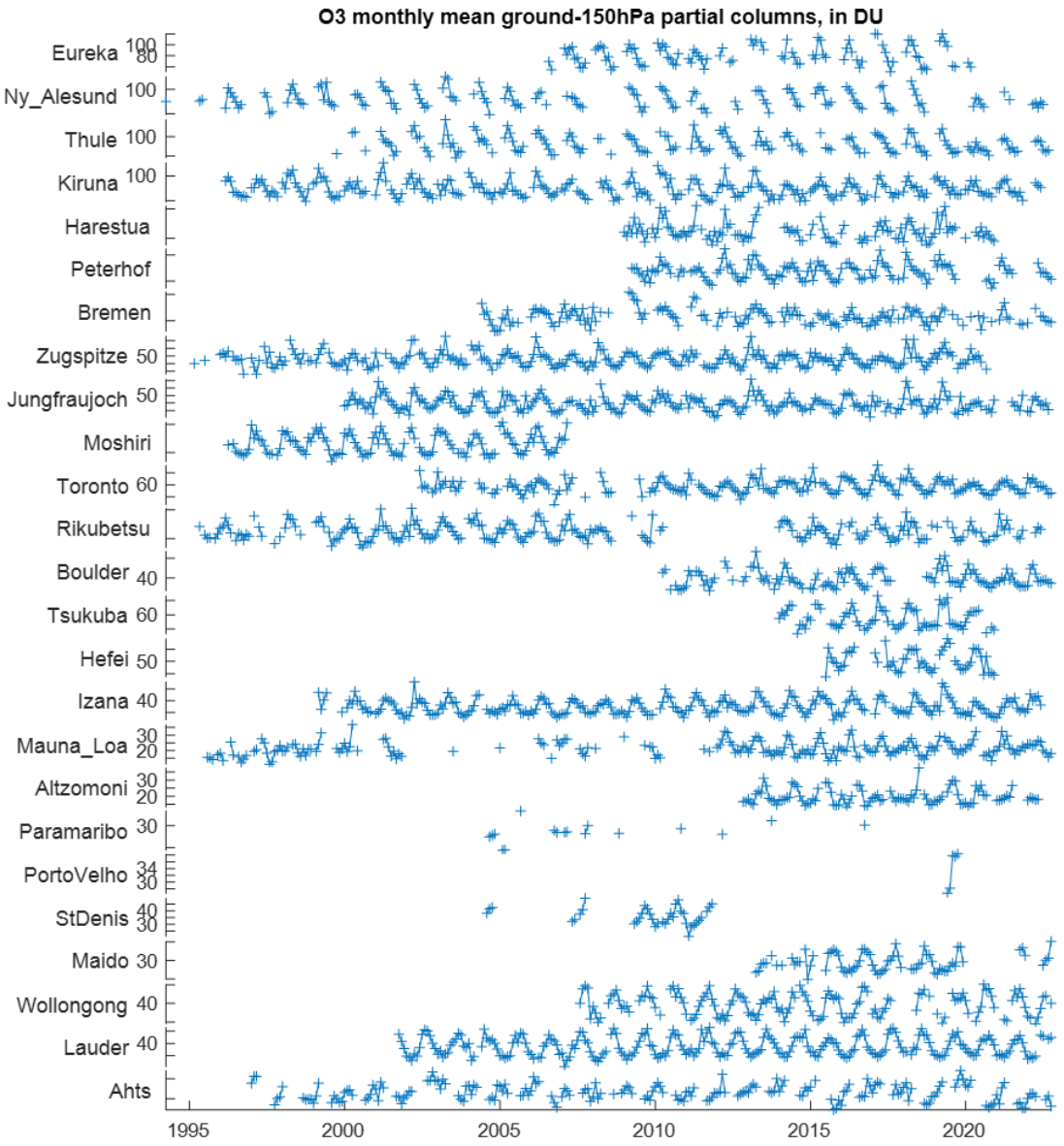




- 43 sites (green dots) with homogenized ozone profile data
- profile data available at ftp-server

https://hegiftom.meteo.be/datasets/ozonesondes

Homogenized datasets: FTIR



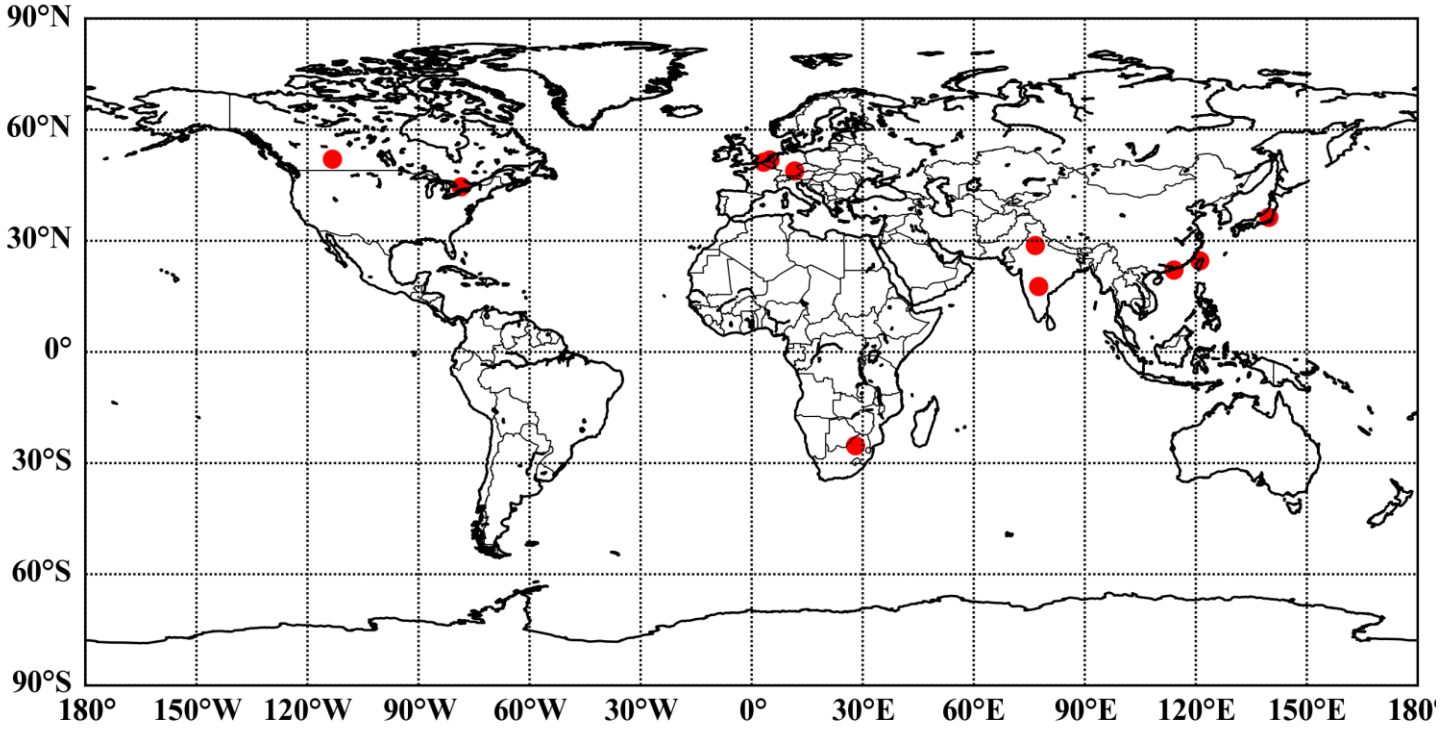
- 25 sites (22 active in O_3) providing O_3 data. See NDACC Infrared WG: https://www2.acom.ucar.edu/irwg
- oldest date back to the mid 90s, most since mid 2000s
- those sites also provide CO/HCHO

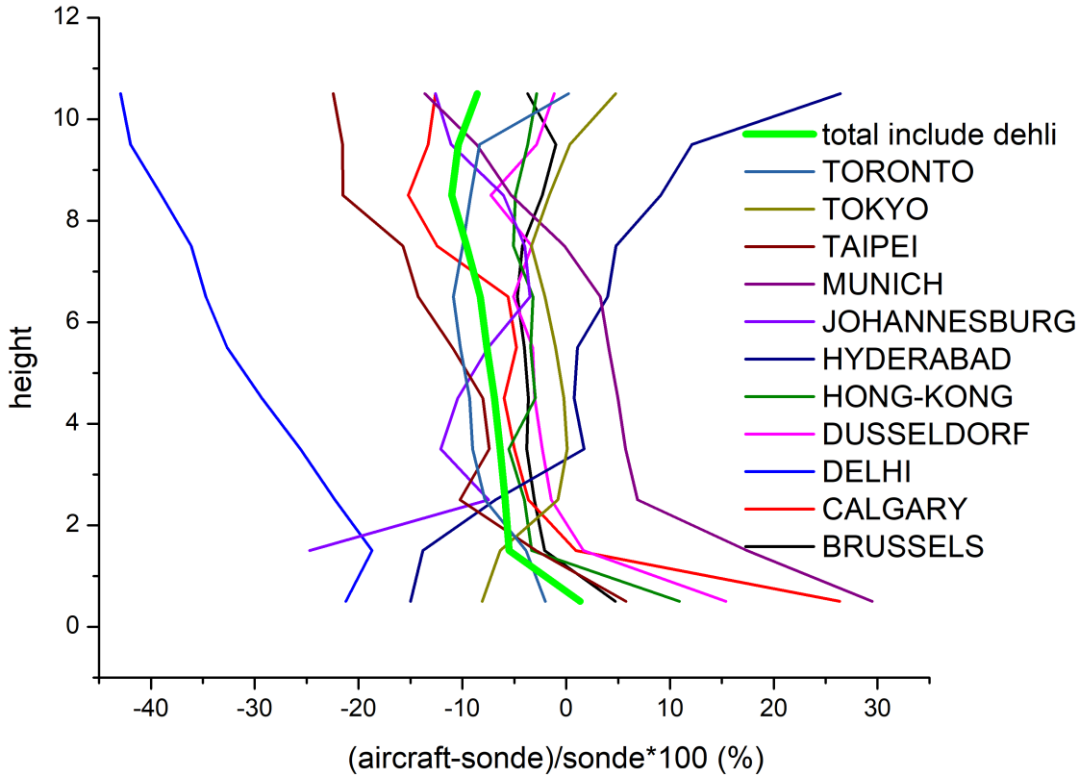
https://hegiftom.meteo.be/datasets/ftir

External Consistency: intercomparisons

- **Deliverable:** TOAR-II Intercomparison Guidelines for Observations of Tropospheric Column Ozone and Tropospheric Ozone Profiles (https://igacproject.org/sites/default/files/2022-03/TOAR-II_Guidelines_for_TCO_and_Profile_Intercomparisons.pdf)

IAGOS vs. sondes at 11 stations



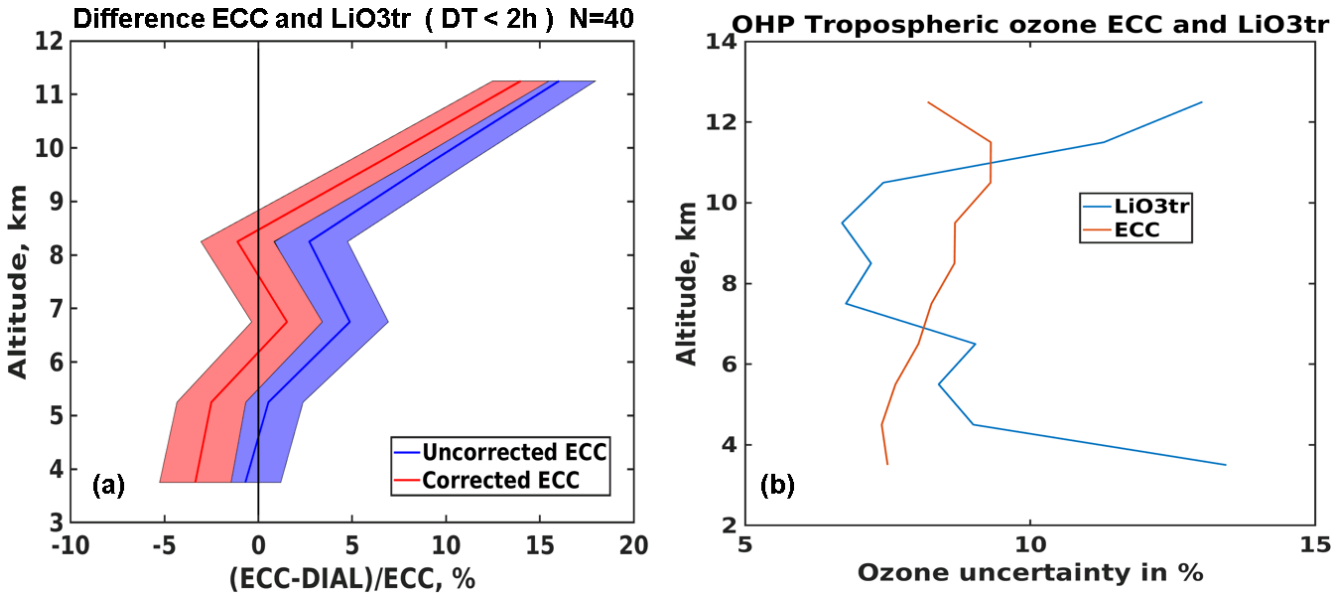


Wang & Tarasick, in preparation

External Consistency: intercomparisons

Intercomparisons: comparison of (tropospheric) ozone retrievals from different ground-based instruments at dedicated sites

OHP (France)



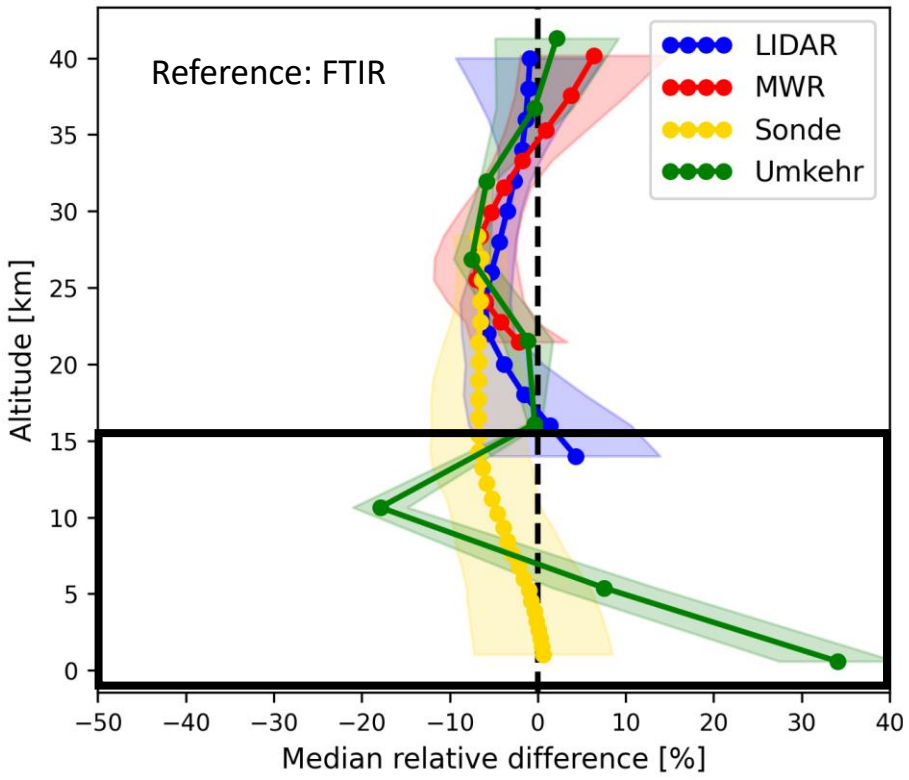
better agreement between **corrected** ozonesondes and tropospheric lidar at altitudes where instrument uncertainties are minimal!

Ancellet et al., AMT, 2022

External Consistency: intercomparisons

Intercomparisons: comparison of (tropospheric) ozone retrievals from different ground-based instruments at dedicated sites

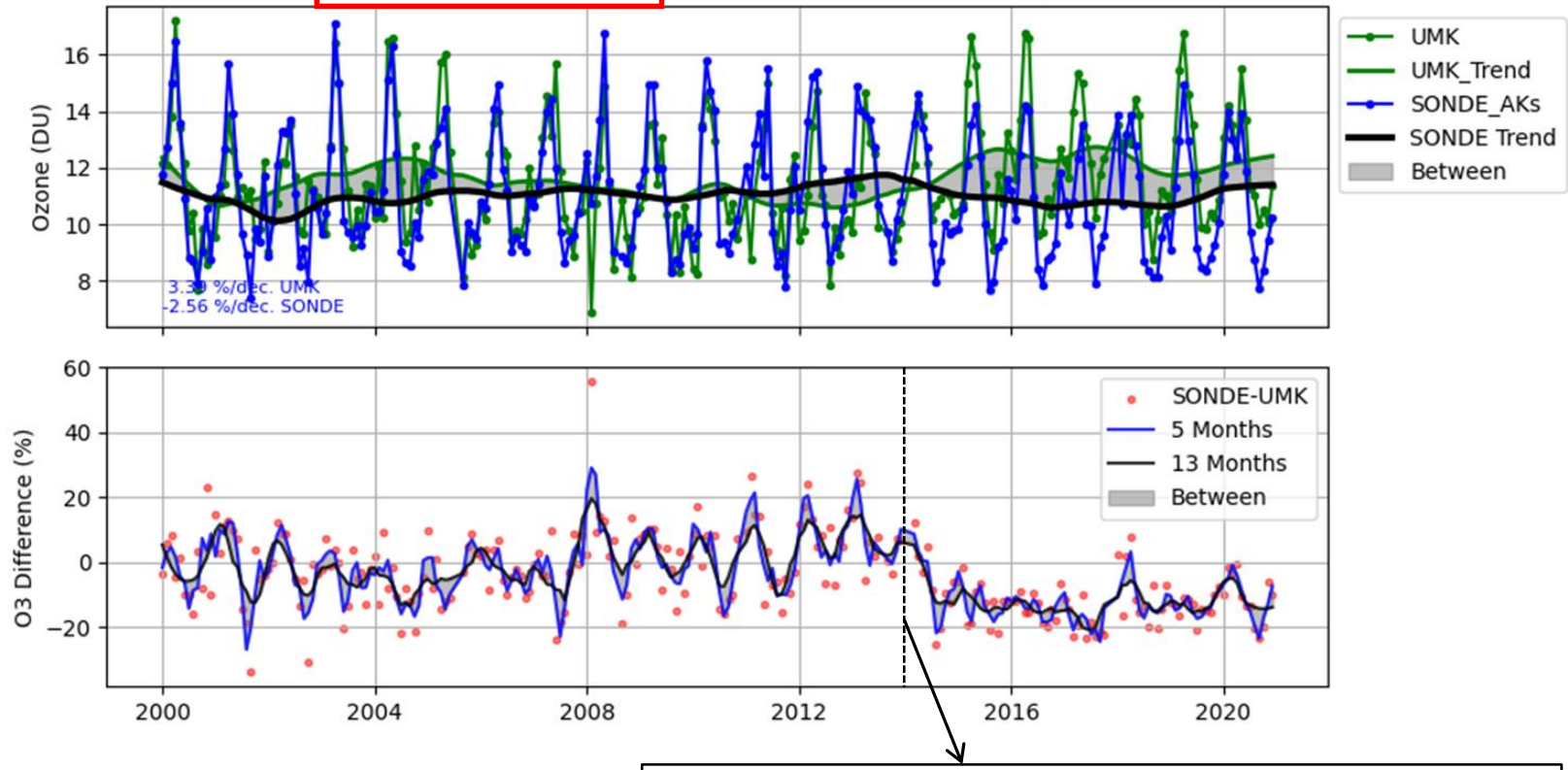
Lauder (New Zealand)



Björklund et al., in preparation

Mauna Loa (MLO) Hawaii (19.5 N, 155.6 W)

Layer 1 : 1000 – 250 hPa



drop in tropospheric ozone content in ozonesonde in 2014

Effertz et al., in preparation

Tropospheric ozone column trend estimates

Starting point:

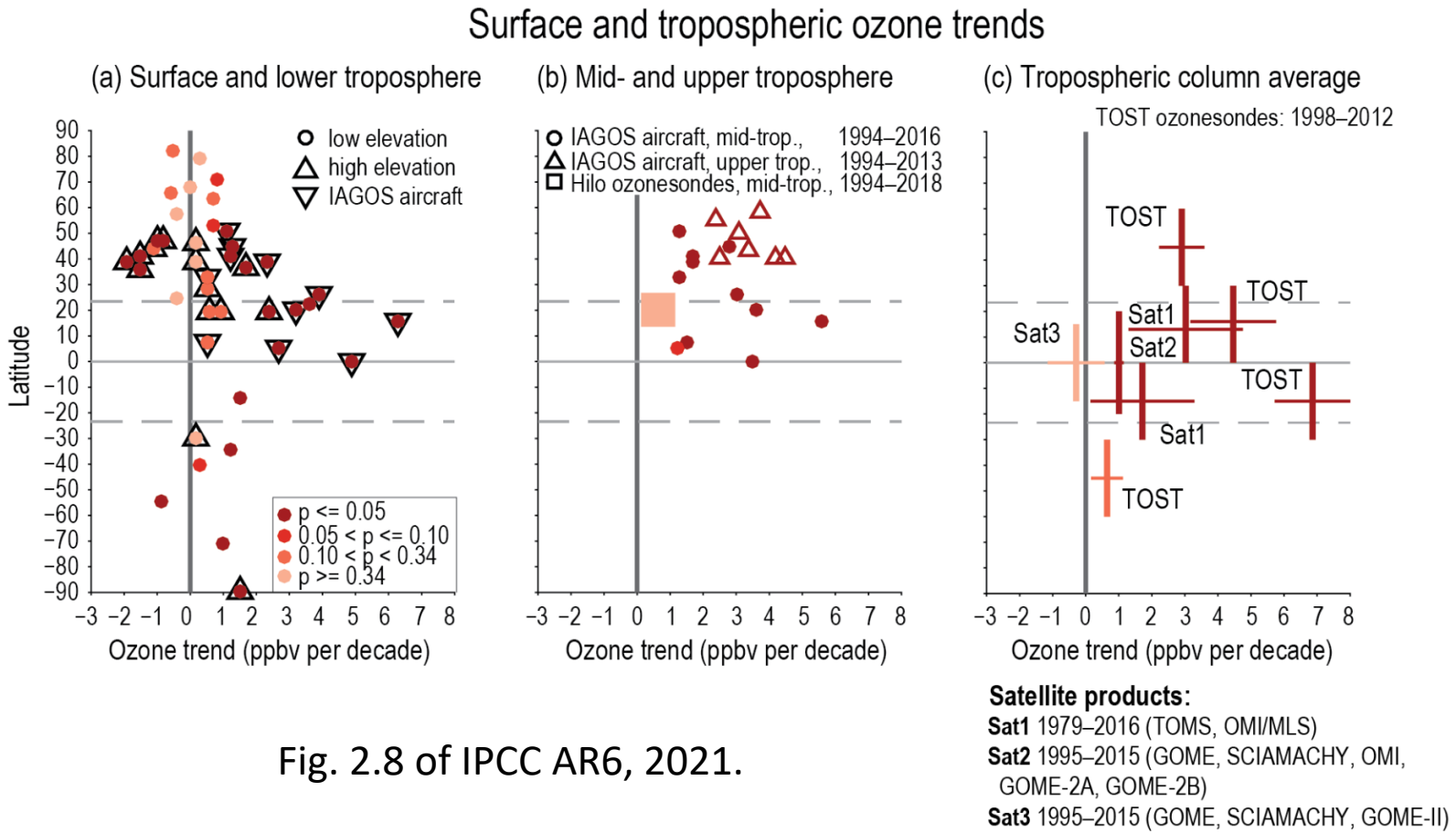
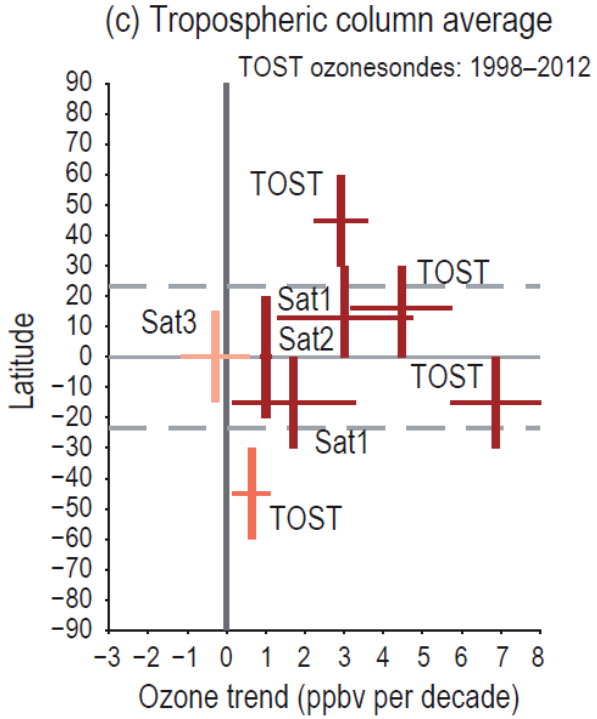


Fig. 2.8 of IPCC AR6, 2021.

- for **individual** HEGIFTOM sites (ozonesondes, IAGOS, FTIR, Lidar, Umkehr)
- different (partial) tropospheric ozone column metrics
- consistency in used trend estimation tools (QR vs. MLR)
- consistency in time ranges (e.g. 2000-2002 till 2019-…)
- consistency in units (ppbv/dec vs. DU/dec)
- = **starting** figures
- = **MINIMAL** figures

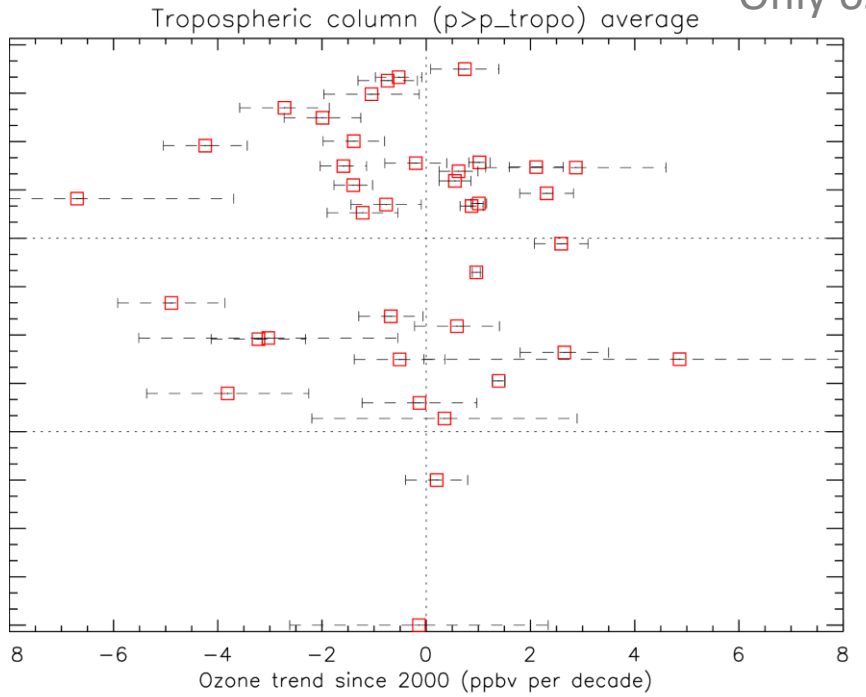
Tropospheric ozone column trend estimates

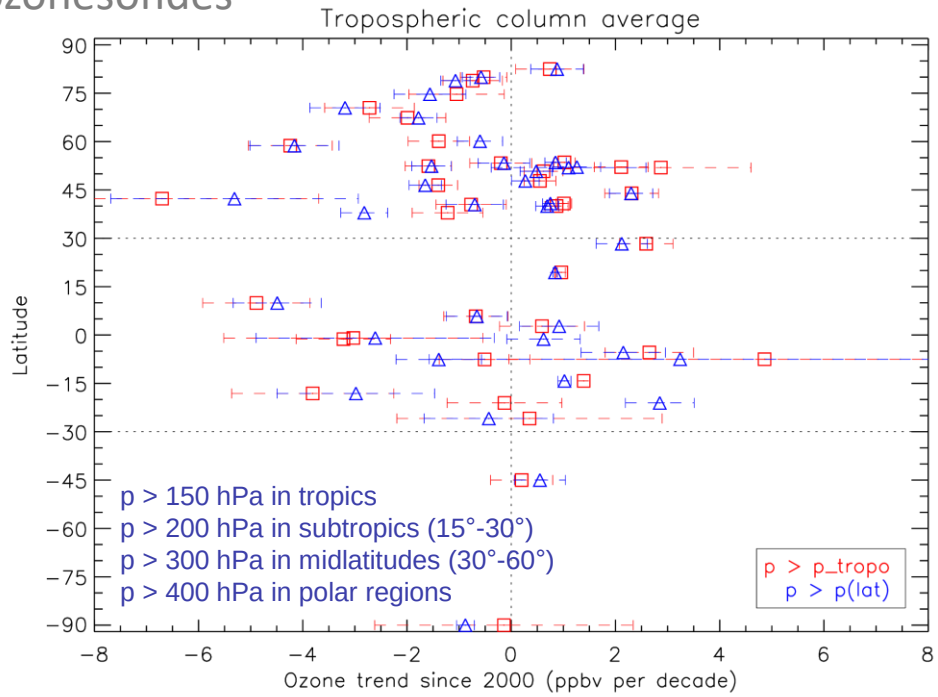
- all (partial) tropospheric ozone columns have been calculated for all sites/techniques



Satellite products:
Sat1 1979–2016 (TOMS, OMI/MLS)
Sat2 1995–2015 (GOME, SCIAMACHY, OMI, GOME-2A, GOME-2B)
Sat3 1995–2015 (GOME, SCIAMACHY, GOME-II)

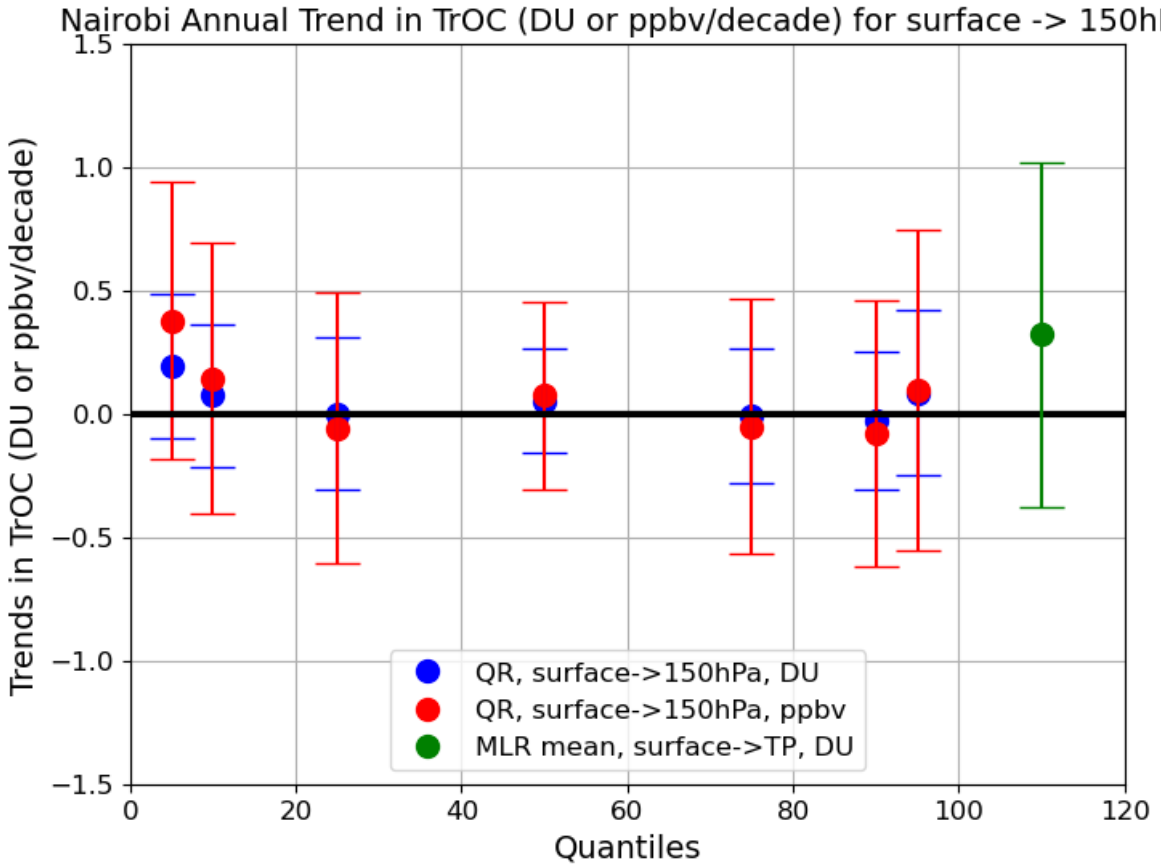
Only ozonesondes



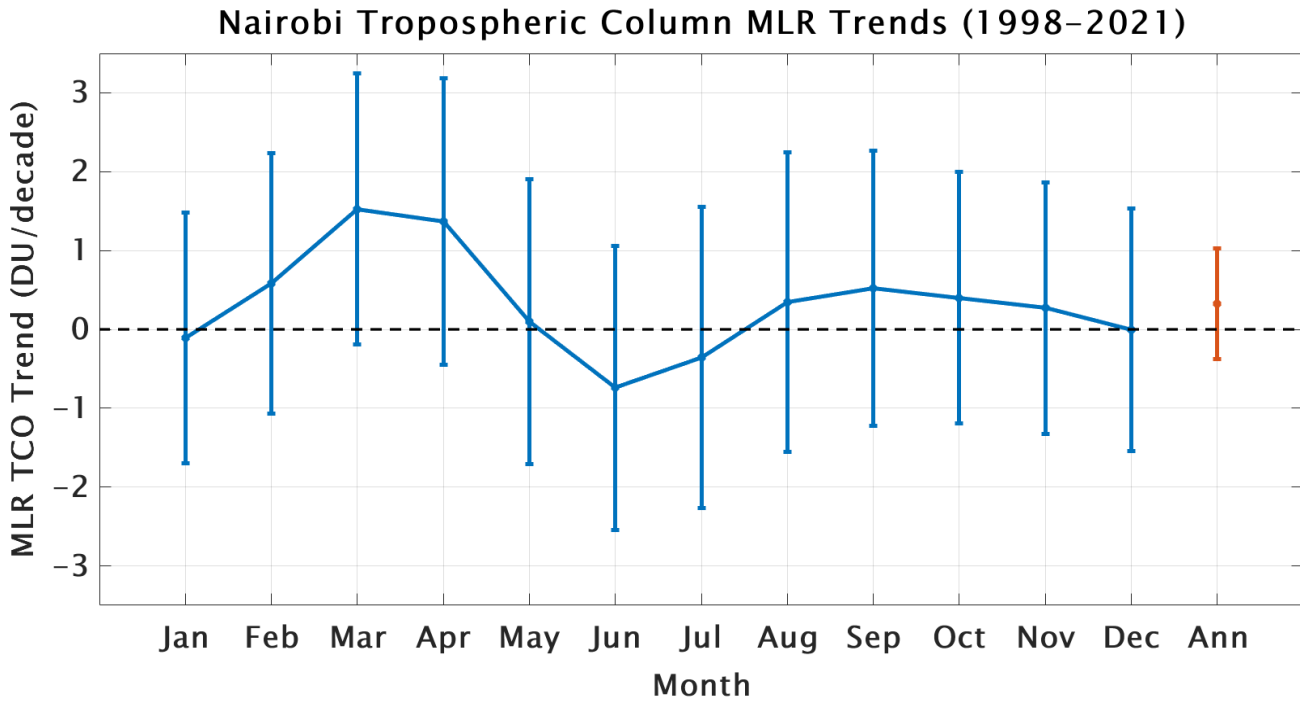


- simple linear regression trend estimation (just for illustration!)
- different metrics = different trends for bulk of stations!
- not only function of latitude!
- much more analysis (and tropospheric ozone column data validation) needed!

Tropospheric ozone column trend estimates



Nairobi ozonesondes



different trend estimation tools provide complementary information!

Outlook

- Homogenized profile data from ground-based instruments described/ available at HEGIFTOM website
- **Coming soon:** time series of (partial) tropospheric ozone columns from all instruments
- intercomparison studies in the pipeline + more are needed!
- study the **spatial and temporal representativeness** of ground-based free tropospheric measurements, in collaboration with TOAR-II chemical reanalysis focus working group
- Tropospheric ozone trends from ground-based instruments will be provided for the TOAR-II Climate Assessment
- more information: http://hegiftom.meteo.be